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Sensitivity of a satellite-derived drought index under soil moisture-limited vs. energy-limited evapotranspiration

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Introduction

Soil moisture is a critical control of **evapotranspiration** or latent heat flux (LE) in dryland areas which cover 40% of the Earth. However, these areas also undergo periods of radiation-controlled evapotranspiration which compromises some satellite approaches estimating LE with surface temperature.

We tested the use of the **Temperature Vegetation Dryness Index (*TVDI*)** from Sandholt et al. (2002) to estimate the ratio of actual/potential LE using **MODIS 8-day satellite** data. We established the conditions for operational application in large regions with bioclimatic gradients and the accuracy of the method.

Objectives

a) **Validate** surface energy fluxes derived from the *TVDI* at sites with different evapotranspiration controls and compare with alternative methods.

b) Assess the role of **spatial heterogeneity** of climatic variables on *TVDI* errors.

c) **Sensitivity** of the *TVDI* to parameterizations for (i) Tair inputs, (ii) land cover types and (iii) algorithm determining hydrological boundaries

Conclusion

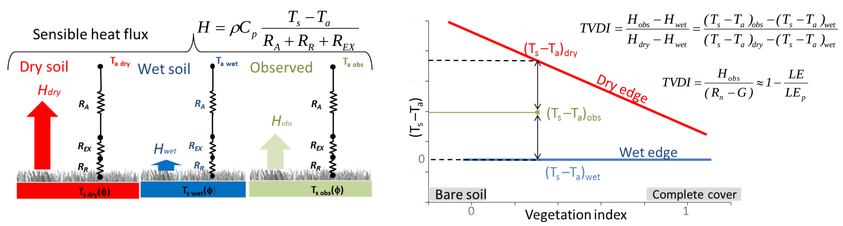
a) **Validation**: *TVDI* was reliable to estimate latent and sensible heat fluxes only under *soil moisture-controlled evapotranspiration* conditions

b) **The effect of spatial heterogeneity in climatic variables depends also on LE controls**. Under energy-controlled LE, *TVDI* errors were related with radiation spatial heterogeneity. In soil moisture-controlled LE, errors were related with water vapor, while radiation was not significant.

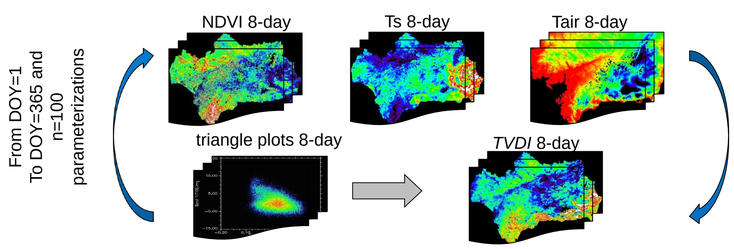
c) ***TVDI*** accuracy was highly **sensitive** to the quality of Tair inputs and the algorithm used to extract hydrological boundaries.

Methodology

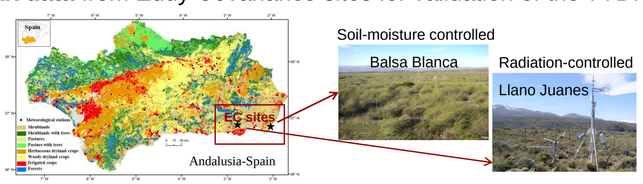
1. Regional estimates of *TVDI* from triangle plots of radiometric temperature (*Ts*) minus air temperature (*Tair*) vs. *NDVI.* It **requires** *wet* and *dry* areas in each image and homogeneous climatic conditions in the region.



Input data: MODIS-Terra, meteorological station data in 2008

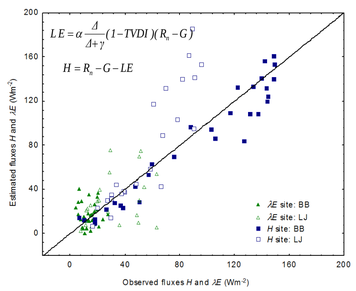


2. Flux data from Eddy Covariance sites for validation of the *TVDI*

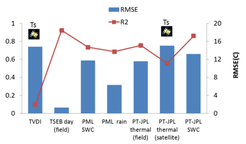


Results

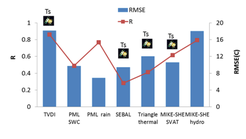
a) Validation of surface fluxes from *TVDI* at two field sites with Eddy Covariance data



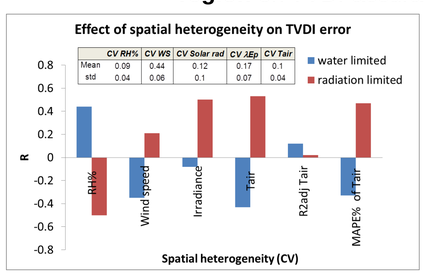
Soil moisture controlled site



Radiation controlled site



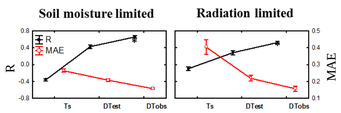
b) Role of spatial heterogeneity of climatic variables in Andalusia region on *TVDI* accuracy



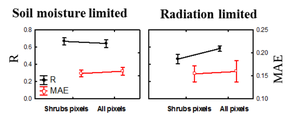
Correlation of *TVDI* errors with spatial CV of climatic variables in the region indicates an effect of spatial heterogeneity. E.g. the *TVDI* errors are not affected by spatial gradients in wind speed (*WS*) in water limited conditions.

c) Sensitivity analysis of the *TVDI* to parameterizations

Tair input quality

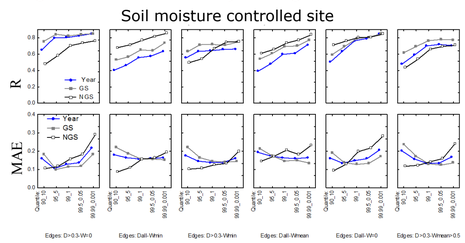


Heterogeneity of land cover



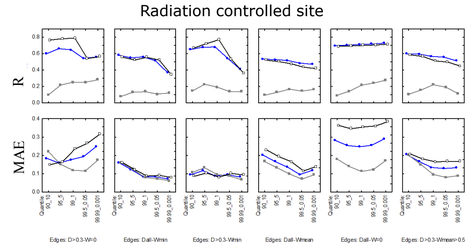
Algorithm to extract hydrological boundaries from triangle plots

Soil moisture controlled site



Changes in correlation (R) and mean average error (MAE) of *TVDI* and the ratio (1-LE/LEp) from field data after changing different parameters.

Radiation controlled site



Statistics during the year, GS (Grow season), and NGS (Non growing season).

Wet and dry edge parameterizations

References in: Garcia, et al., 2014, *Remote Sensing of Environment*, Volume 149, 100-117

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